

Fourth
Semi-Annual Status Report

Grant NGR 03-002-122

"Astrometric and Astrophysical Investigations
of
Comets, Minor Planets, and Satellites"

1 August 1968 - 31 January 1969

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February 3, 1969

FACILITY FORM 602

N69-71709

(ACCESSION NUMBER)

(PAGES)

CR 100035
(NASA CR OR TMX OR AD NUMBER)

(THRU)

none

(CODE)

(CATEGORY)



OBSERVATIONS

As previously, observing time with the 61-inch NASA reflecting telescope at the Catalina Station of the Lunar and Planetary Laboratory was scheduled regularly on two or three nights near the time of each new moon for astrometric observations of comets, minor planets, and satellites. Part of the December time and two nights in January were lost because of bad weather.

Recovery observations (the first during the current perihelion passage) were made of the returning periodic comets Comas Solá (recovered October 27, magnitude 20.2) and Harrington-Abell (recovered November 23, magnitude 19.4; probable pre-recovery observation on October 27, magnitude 20.5). Both comets were close to the predicted positions.

Special time was scheduled on December 21 and 22 for optical tracking of the Apollo 8 spacecraft on translunar orbit, and on January 8 and 9 for special observations jointly with A.M.J. Gehrels for astrometric and photometric observations of the close-approach asteroid (1620) Geographos.

Observational statistics are as follows:

Number of nights	13
Number of plates obtained	86
Number of objects observed:	
Planetary satellites	1
Minor planets	9
Periodic comets	4
Near-parabolic comets	<u>6</u>
	20

<u>Satellites</u>	<u>Minor Planets</u>	<u>P/Comets</u>	<u>Parabolic Comets</u>
Saturn IX	(1161) Thessalia	Perrine-Mrkos	1967n Ikeya-Seki
(Phoebe)	(1297) Quadea	*Comas Solá	1968a Tago-Honda-
	(1566) Icarus	*Harrington-	Yamamoto
	(1580) Betulia	Abell	1968b Whitaker-Thomas
	(1620) Geographos	Reinmuth 2	1968c Honda
	(1696) 1939 FF		1968d Bally-Clayton
	(1713) 1951 SC		1968f Wild
	1947 NH		
	1968 UA	*Recovery	

Observations of (1620) Geographos in December and January initiate a series that we anticipate extending for about a year, to include the rare close approach of this minor planet to within 0.06 astronomical units of the earth on August 27, 1969. (1566) Icarus, (1620) Geographos, and (1685) Toro are the only earth-crossing minor planets for which reliable predictions of position are possible. It is interesting coincidence that the close approach of Geographos should follow so closely on the heels of the close approach of Icarus in 1968. Cooperative work with Dr. A. M. J. Gehrels to obtain photopolarimetric observations is again in progress.

The Apollo 8 spacecraft was observed visually and photographically in translunar orbit on December 21/22 and 22/23 with the NASA 61-inch telescope. The project was undertaken in collaboration with Dr. G. P. Kuiper and Mr. John Fountain at the suggestion of, and with positional data supplied by, Dr. Harold Liemohn of the Boeing Scientific Research Laboratories. About 35 exposures were obtained each night, some at sidereal rate, and some with the telescope motions preset to compensate for the motion of the spacecraft. A representative print is attached to this report.

As an aid to observers at a few other institutions, we have for some time distributed copies of our moving object observing list for each new-moon observing run. The list is compiled as the basis for planning of our own observations. Included in sequence through the night are all comets for which current ephemerides are available, as well as special minor planets selected on the basis of unusual interest coupled with faintness or other characteristic that makes them difficult for other observers. The major planets are included for their intrinsic interest to those with whom we compete for telescope time and to keep track of satellite observing seasons as well as sources of spurious "ghost" comets. A copy of the list for February 18, 1969, is attached to this report. It shows eleven comets potentially under current observation, only one of them brighter than 16th magnitude. Only at the Tokyo Observatory and at the Lunar and Planetary Laboratory are comets fainter than 16th magnitude observed regularly.

MEASUREMENT AND REDUCTION OF ASTROMETRIC OBSERVATIONS

Measurement of photographic plates and reduction of accurate positions have proceeded in parallel with the observational work, as previously, with the continued assistance of Mrs. Barbara Schreur.

Statistics for the report period:

Plates measured	78
Plates reduced	89
(Plates with insufficient ref. stars	7)

Mr. Arthur Clements, a graduate student in astronomy, joined the project on September 1, 1968. He has written and tested the program for the CDC 6400 Computer of the University's Numerical Analysis Laboratory for reduction of secondary reference star positions from field plates taken with any astrographic telescope. This two-step reduction procedure, described in the previous report, is necessary when insufficient reference stars are available from the Astrographic Catalogue within the limited field of large reflecting telescopes. The program can also be used in an abbreviated form for reduction of the position of a single object directly from wide-field astrographic plates. This is the usual reduction problem at most observatories engaged in observations of comets and minor planets with small instruments. The field of view is invariably extensive enough to include a sufficient number of stars for which right ascensions and declinations of high quality can be taken directly from zone catalogs or from the Smithsonian Star Catalog.

Results of position determinations, as previously, have been made available through the I.A.U. Central Telegram Bureau via the Circulars whenever they would be immediately useful. This was the case with early positions of the newly-discovered comets 1968 e, Honda, and 1968 d, Bally-Clayton, as well as with the recovery announcements of P/Comas Soldá and P/Harrington-Abell.

ASTROPHYSICAL PROBLEMS OF COMETS

As previously, graduate students have participated in astrophysical investigations of comets as a part of special problems work. Arthur Clements and Lyn Doose have made a spectrophotometric analysis of two calibrated, but previously unmeasured, low-dispersion spectra of Comet Abell, 1953 g, which I obtained in May 1954 with a prism spectrograph attached to the 36-inch refractor of the Lick Observatory. In addition to a well-defined narrow tail, the comet had a second short, broad tail at a considerable angle to the first. The continuum was strong, with superposed normal emission bands of the coma.

It had been hoped when Clements and Doose undertook a problem in cometary spectra that it would be possible to obtain new observational material at the perihelion opposition of P/Perrine-Mrkos early in November 1968. That comet, though expected to brighten possibly to magnitude 11, eluded all efforts at recovery until the 48-inch Palomar Schmidt was brought to bear on the problem by G. A. Tammann late in November. At recovery the comet was of magnitude 15 to 16, and unexpectedly far from the calculated position. According to some reports it did brighten to total magnitude 12 briefly in December, but there was no opportunity for us to obtain either photoelectric or spectrographic observations. This was especially unfortunate, since so few short-period comets ever become bright enough for physical observations.

Charles Snell has concluded his research paper for his M.S. degree concerned with a study of observational evidence regarding "disappearing" comets. His principal conclusions include these:

- 1) Near-parabolic and short-periodic comets show comparable frequencies of activity related to fading and disruption. There seems to be no significantly greater fragility of comets identified through dynamical characteristics as "new."
- 2) Near-parabolic comets on the average are brighter after perihelion passage than before, by an amount of the order of one magnitude.
- 3) A fading of about one magnitude as a consequence of the first perihelion passage would be enough to cause the observational disappearance of enough comets, on the assumption of origin in the Oort cloud, to be consistent with the observed distribution of $1/a$.
- 4) There is no direct evidence for such fading.

Early in December I spent a full day with Drs. Bertram Donn and Jürgen Rahe at Goddard Space Flight Center reviewing material for Part I of the Atlas of Cometary Forms: Structures Near the Nucleus. In addition to introductory text and reference material, about 100 pages of drawings and photographs have been arranged to illustrate ion structures in the vicinity of the nucleus. Various instrumental and observational effects are also illustrated. Editorial work was finished during January, and graphic art work is now in progress. It is anticipated that material will be ready for the press during the spring. Dr. Donn has been working with Dr. Jocelyn Gill, NASA Headquarters, regarding publication, which is to be sponsored by NASA.

SCHMIDT TELESCOPE

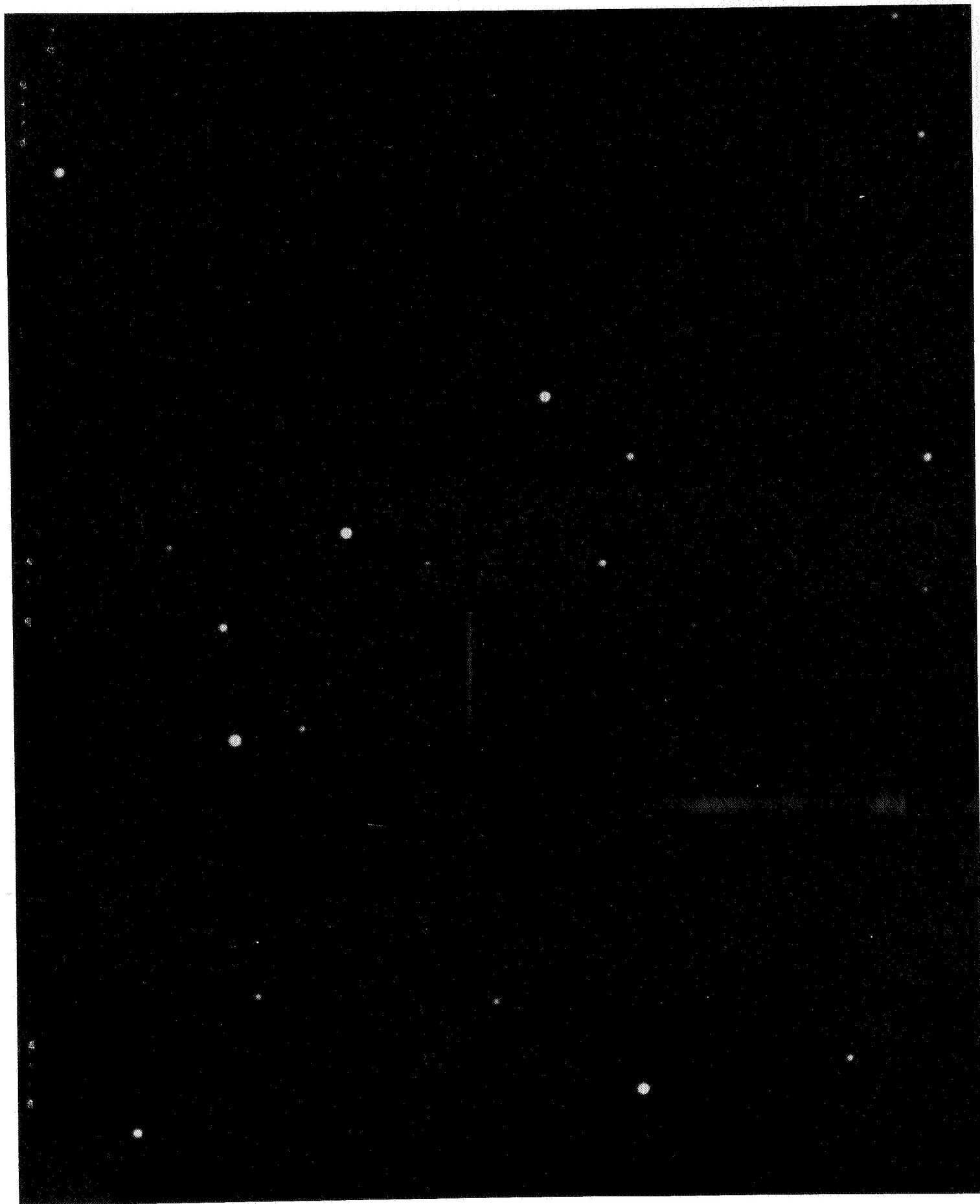
While in Austin, Texas, in December for the meeting of the American Astronomical Society, I conferred with Messrs. W. L. Richards and Jack Guyer of Astro Mechanics, Inc., regarding design of the proposed new yoke mounting for the Schmidt telescope. Although funding delays have not been entirely resolved, the situation for early resolution now seems promising.

Elizabeth Roemer

CAPTION

The Apollo 8 spacecraft as photographed in trans-lunar orbit at 2^h 01^m UT on December 22 with the 61-inch NASA reflector at the Catalina Station of the Lunar and Planetary Laboratory. The exposure was 2 min on Kodak 4X film with the telescope driving at sidereal rate.

The three trails--a steady one in the center, an interrupted one to one side, and a weak one to the other side--presumably correspond to the command-service module, the Saturn booster, and panels of the service-lunar module adapter. Cycles of flashes with a period of a few seconds were observed visually.



MOVING OBJECT OBSERVING LIST

1969 February 18

<u>Object</u>		<u>α</u>	<u>δ</u>	<u>Mag.</u>	<u>Last LPL Observation</u>
	SUN	22 ^h 05 ^m	-11°8		
V	Venus	0 46	+ 8.3		
1968 f	Wild	1 11	+ 9.2	19.6+	Dec. 23
S	Saturn	1 24	+ 6.3		
1968 UA	Soulié Object	2 00	+ 7.5	17.2	sg. Dec. 22
1968 i	P/Harrington-Abell	3 40	+ 2.8	19.0	Dec. 23 (poor)
1967 n	Ikeya-Seki	4 10	+25.4	18.2	Nov. 23
1968 j	Thomas	5 03	+76.8		
(1620)	Geographos	5 43	+38.8	16.7	Jan. 8
1968 h	P/Perrine-Mrkos	6 01	- 2.3	19.5	Dec. 23
1967 e	P/Reinmuth 2	6 50	+23.6	20-22	nf. Oct. 28
(1627)	Ivar	7 59	+19.8	17.5	
1947 NH		8 56	-25.5	16.0	Dec. 23
(1173)	Anchises	9 01	+12.3	17.5	$\Delta M = +0^{\circ}2$?
(1208)	Troilus	9 29	+56.8	16.8	$\Delta M = 0^{\circ}$ (Marsden)
B	Pluto	12 05	+16.9		
U	Uranus	12 13	- 0.6		
J	Jupiter	12 20	- 0.5		
	J VIII				
	J IX				
	J X				
	J XI				
	J XII				
1925 II	P/Schw.-Wach. 1	13 46	-20.8		
1963 VI	P/Ashbrook-Jackson	14 37	-22.5	21+	
1953 EA		14 56	-19.8	18.2	
M	Mars	15 38	-18.2		
1967 i	P/Schw.-Wach. 2	15 46	-15.8	17.7+	
N	Neptune	15 47	-18.2		
1968 e	Honda	18 15	-19.4	12.8	
1968 d	Bally-Clayton	18 48	+61.6	18.0	
(1685)	Toro	19 09	-24.0	19.8	
M	Mercury	20 21	-18.5		